Technical constraints on Biomass gasification: Critical bottleneck for the survival of VSPPs in Thailand

by

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Presentation outline

- Backgrounds
- Abbreviations
- Technical Review
- Status of VSPPs using biomass gasification technology in Thailand
- Technical constraints on biomass gasification for power generation purpose
- Conclusions

Backgrounds

- Intensive campaign for encouraging and supporting small private power producers (<1 - <10 MW) in Thailand has been launched since the early 1990s
- Biomass gasification combined with gas engine generator was introduced and recommended as the most suitable technology for power plant with <1 - <10 MW installed capacity, i.e. VSPP
- Biomass gasification power plants in Thailand more likely to close down after 3 years due to problems caused by gasification process*
- Biomass gasification power plant with <1 MW installed capacity would not be viable economically**

*ASIAN Institute of Technology, (2003)

**Energy for Environment Foundation, (2012)

Abbreviations

VSPP = Very Small Power Producer

= Renewable energy power plant with <1 - <10 MW installed capacity

EGAT = Electricity Generation Authority of Thailand

= National power producer/provider

MEA = Metropolitan Electricity Authority

= Power provider for Bangkok and vicinity

PEA = Provincial Electricity Authority

= Power provider for areas beyond Bangkok and vicinity

Technical Review
Gasification process

Process mechanism

- Operating Temperature 500 – 1,200 ° C
- Inlet air 1/3 of that required for complete combustion (Partial oxidation)
- Combinations of Exothermic and Endothermic reactions

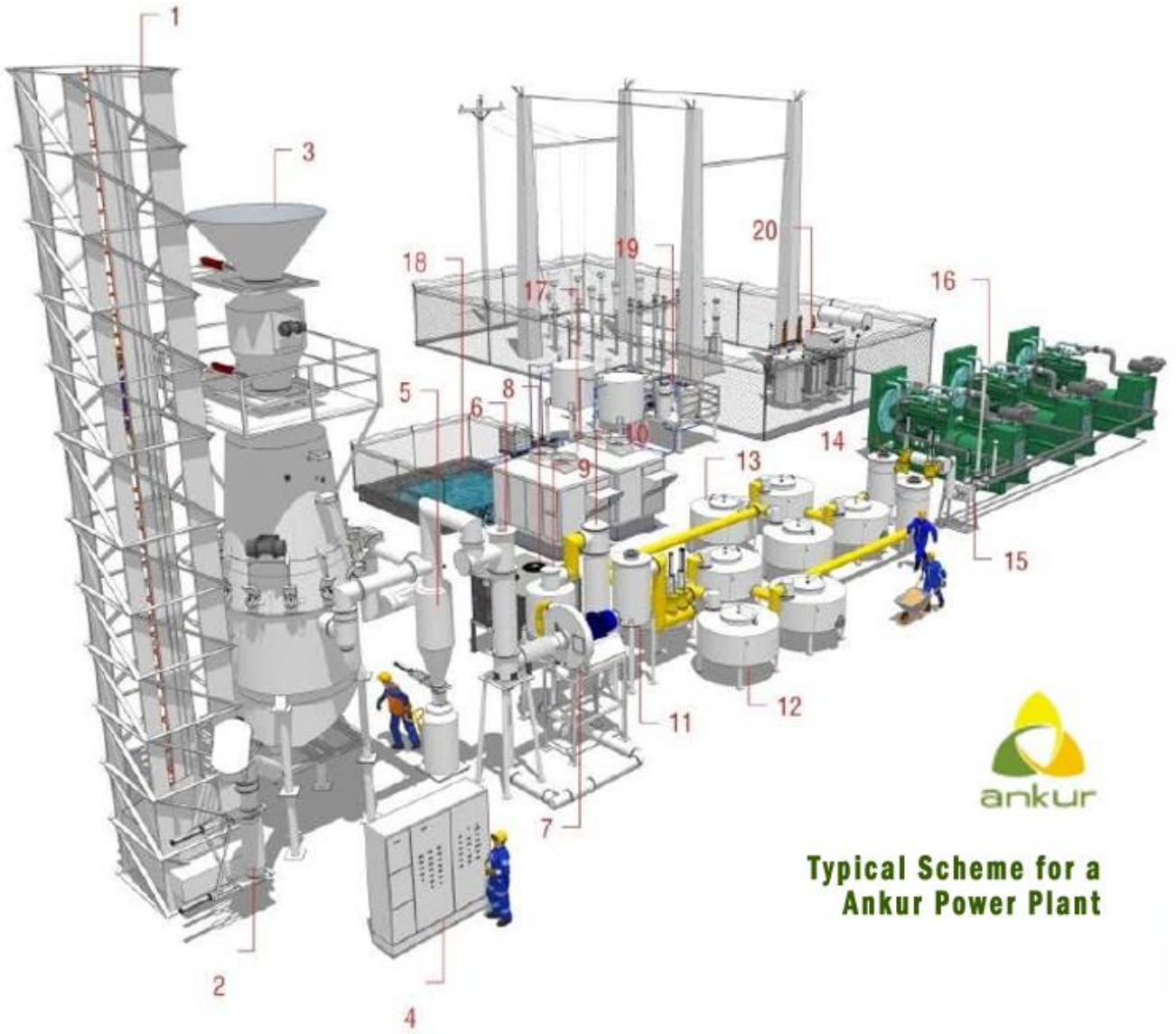
Factors affecting process performance

- Reactor's physical figure
- Operating temperature, i.e. higher is better
- Size (1.5 – 2 inch) and moisture content (< 20%) of feedstock

Products

- Gas: Synthetic gas (CO, H_2, CH_4), CO_2, NO_2 and H_2O
- Vapor: heavy hydrocarbons (Condensable), light hydrocarbons (Incondensable)
- Solid: char, ash

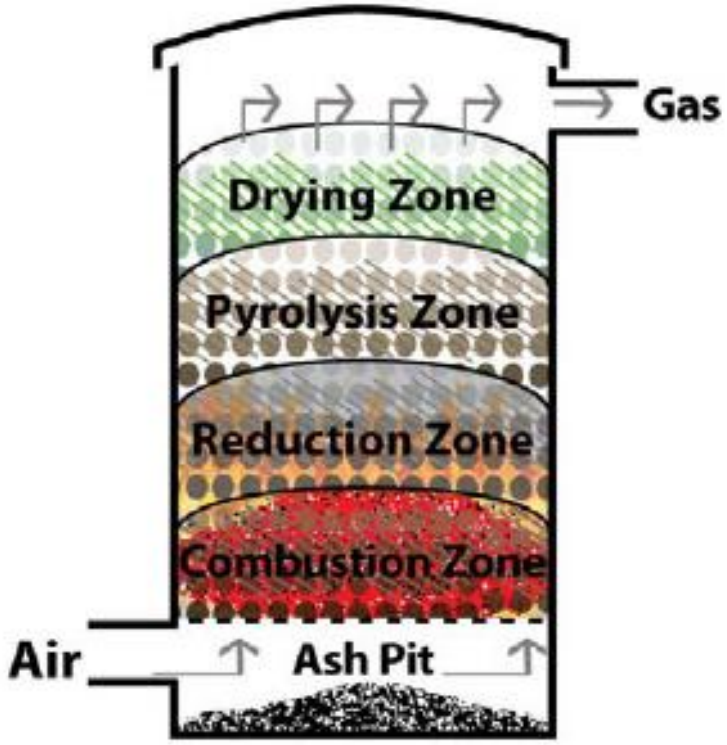
Typical Biomass gasification VSPP in Thailand



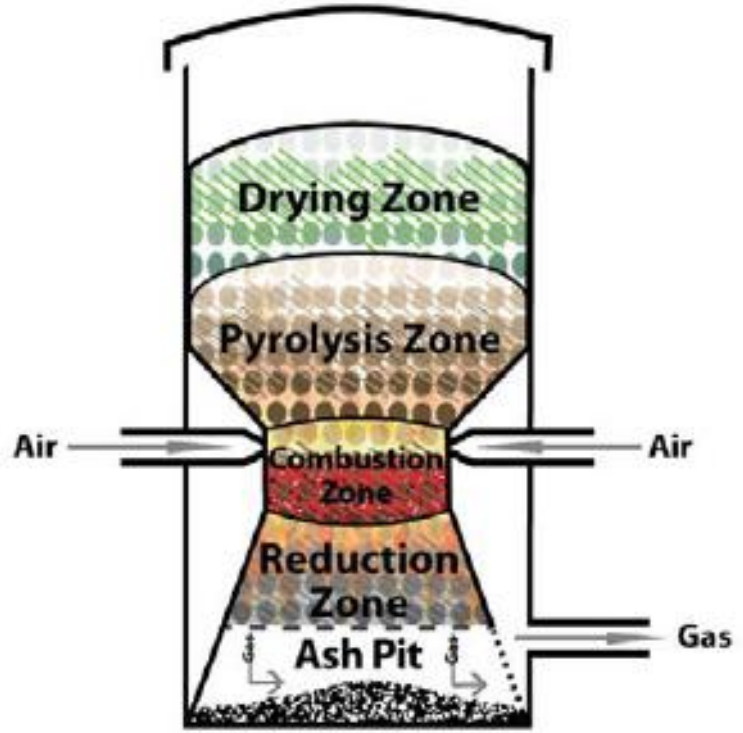
Source: http://aboriginalankur.com/author/admin/

Gasifiers used by VSPPs

Fixed bed gasifier



Updraft gasifier



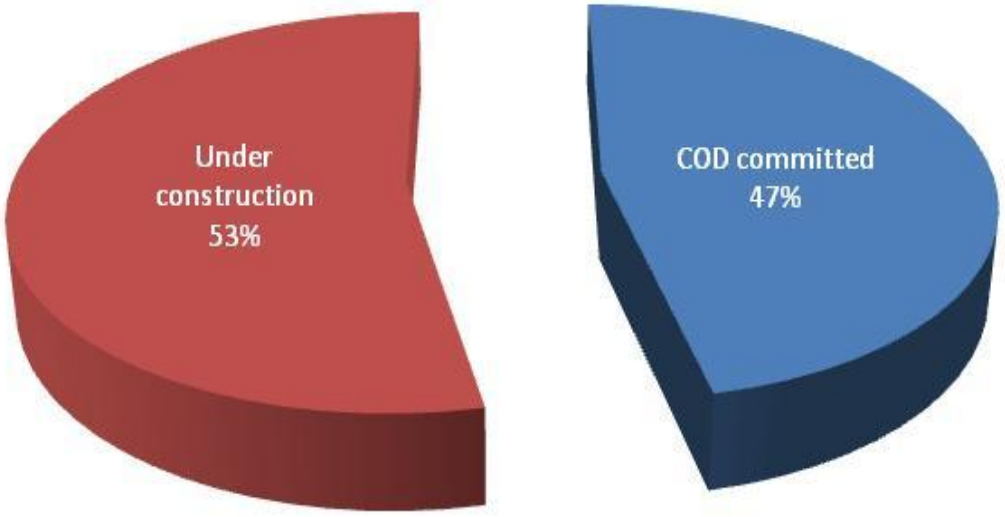
Downdraft gasifier

Source: Thomas B. Reed and Agua Das, 1988

Status of VSPPs using biomass gasification technology in Thailand

Total license granted VSPPs 30 plants

(1991 - 2003)



COD* committed	14 plants
Under construction	16 plants

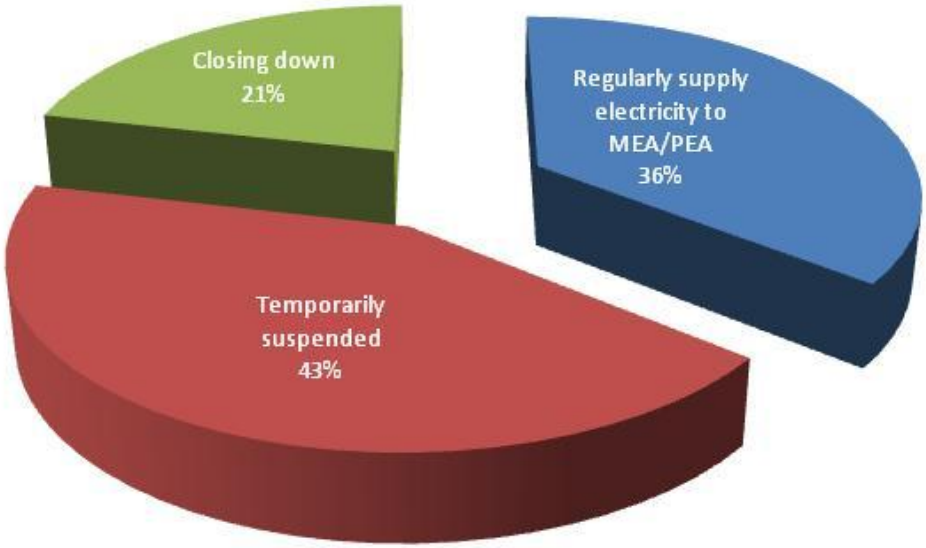
* Commercial operation date

Status of VSPPs using biomass gasification technology in Thailand

(Continued)

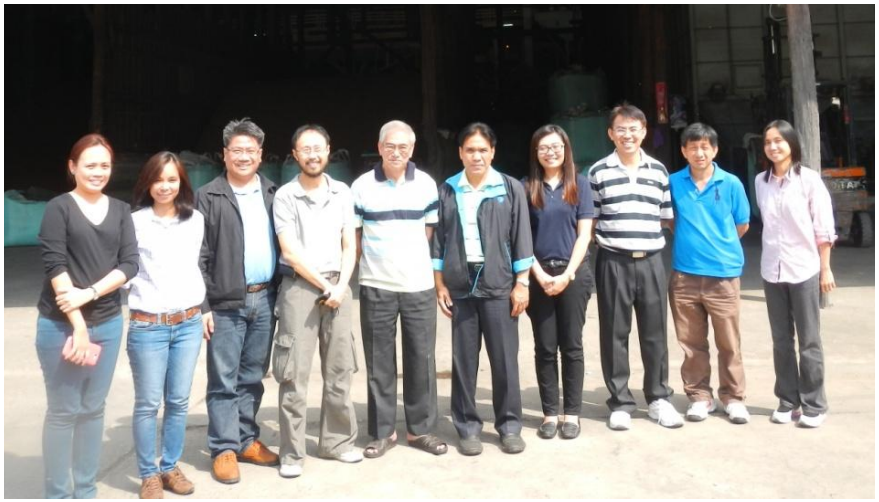
Total COD* committed VSPPs 14 plants

(1991 - 2000)



Regularly supply electricity to MEA/PEA	5 plants
Temporarily suspended	6 plants
Closing down	3 plants

* Commercial operation date



* Small and Medium Enterprises

** Thailand Research Fund – Electricity Generation Authority of Thailand

Field surveys on 10 VSPPs

(Sep 2014 – Jun 2015)

Technical constraints on biomass gasification for power generation purpose

1. Low efficiency
2. Limited continuous operation duration
3. Sensitive to feedstock's size and moisture content
4. Produced large amounts of by-products/wastes

Constraint 1: Low efficiency

Causes:

- Design of gasifier
- User's application

Impacts:

- Low operating temperature
- Low quantity and quality, i.e. high tar contamination, gas produced
- Inefficient feedstock consumption

Constraint 2:

Limited continuous operation duration

Average operation duration 2,800 - 3,500 hours/year

Causes:

Frequent unscheduled shutdowns due to accumulation of tar in plumbing, accessories and/or engine's parts

Impacts:

- Losing Income due to less electricity produced
- Increasing operating cost, i.e. for unscheduled maintenances and/or premature spare parts replacements

Constraint 3:

Sensitive to feedstock's size and moisture content

Causes :

- Large numbers of big voids in pile/column of feedstock, i.e. oversized feedstock
- Compact pile/column of feedstock with small number of tiny voids, i.e. undersized feedstock
- Damped pile/column of feedstock, i.e. > 20% MC

Impacts :

- Non-uniform zonal temperature
- Obstructing inlet/outlet gases flow, increasing waste char
- Extended start-up time and lower operating temperature

Constraint 4:

Produced large amounts of by-products/wastes

Wastewater

(4-6 m^3/MW/day)

Bottom ash/char

(4 tons/MW/Day)

Tar

(400-700 liters/MW/Day)

Constraint 4:
Produced large amounts of by-products/wastes

Causes :

Typical characteristic of fixed bed gasifiers

Impacts :

- Increasing investment, i.e. sufficient appropriate waste treatment system
- Increasing external cost, i.e. Financial compensation to human health and ecosystem deterioration and Corporate Social Responsibility (CSR) activities
- Risk of losing income, i.e. being shut down by public/community opposition due to environmental issues

Conclusions

Technical constraints on biomass gasification considered as a critical bottleneck for the survival of VSPPs due to following issues:

Increasing (unplanned) investment

Increasing operating costs

Increasing external costs

Losing incomes

64% of COD committed VSPPs were left idle because of either closing down due to accumulated deficit or suspended because it was too costly to operate

Acknowledgement

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Thank you

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